SMALL WATERSHED STUDIES

50 YEARS IN THE LOOKOUT CREEK BASIN

background

Small watershed studies comprise the longest-running research at the H.J Andrews Experimental Forest, with records dating back 50 years. Historically, areas of focus have included the effects of forest harvest and associated road building on stream flow, water quality and sediment yield, stream temperature, and forest revegetation. More recently, research interests have expanded to include landscape patterns of vegetation recovery, stream ecosystem processes, and alternative stream flow pathways. The long-term nature of these studies and their importance to issues such as water quality, fish habitat, and economics, demonstrate how basic research can benefit management decisions. From these studies, scientists hope to predict larger-scale responses of landscape structure and ecosystem processes to natural and human-caused forest disturbance. The following studies take place in eight small watersheds (less than one square kilometer) in and adjacent to the H. J. Andrews Experimental Forest.

study sites

Paired sites	Area (ha)	Elevation (m)	Harvest type	Percent Cut	Year(s) harvested
Watershed 1	100	460-990	Clear-cut, no roads	100	1962-1966
Watershed 2	60	530-1070	Uncut	0	n/a
Watershed 3	100	490-1070	Patch cut, w/ roads	25	1963
Watershed 6	13	863-1013	Clear-cut	100	1974
Watershed 7	15.4	908-1097	Shelterwood cut	60, 40	1974, 1984
Watershed 8	21.4	955-1190	Uncut	0	n/a
Watershed 9	8.5	425-700	Uncut	0	n/a
Watershed 10	10.2	430-670	Clear-cut	100	1975

The eight watersheds are paired into control and treatment sites, providing both baseline and post-treatment data on the effects of forest harvest. Significant debris flows in 1964 and 1996 scoured the stream channel and riparian zone in watershed 3 in addition to affecting other sites in the forest. These unexpected, natural experiments have also provided unique insights on the effects of forest harvest.

the studies

Hydrology

On its downstream journey, water moves over and through the landscape, affected by a host of complex interactions. Forest harvest can influence peak flows, and forest canopy removal interacts with roads constructed to access harvest patches. Study results indicate that patch clear-cutting was associated with higher peak flows in all five harvested small watersheds in Lookout Creek, and peak flow increases were further increased, especially for large peaks, in watersheds where roads were built in or adjacent to clearcut areas. Forest canopy removal decreases evapotranspiration and may increase snowpack accumulation, leading to wetter soils, whereas roads may contribute to increased peak flows by converting subsurface flow to surface flow. The hyporheic zone, where water moves below and around the stream channel, helps regulate hydrology and is affected by the removal of wood from streams. One new study focuses on the effects of logjams on hyporheic exchange rates. In larger basins, the removal of wood from streams reduces hyporheic exchange and channel roughness. The largest floods affect patterns of riparian vegetation and may increase the movement of wood, changes that have implications on the geomorphology and ecology of streams.

Stream temperature

Temperature has a significant impact on ecosystem processes and biological interactions. In streams, temperature controls rates of metabolism, growth, and decomposition of plants and animal material, affects physical processes such as the solubility of gases, and influences the interactions of stream biota. Stream temperature, discharge, air temperature, pre-

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cipitation, solar radiation, and soil temperatures are monitored from climate stations distributed throughout the research forest. Results show that stream temperatures are influenced by the amount of riparian shading, conduction of heat from alluvial substrates, and sources of incoming water. Harvest of riparian forests led to increased stream temperatures, which may affect aquatic organisms with temperature-dependent life histories.

Revegetation

In harvested areas, Andrews Forest scientists have been studying patterns of plant succession and influences on stream flow. Before Watersheds 1 and 3 were harvested in the 1960s, they were dominated by conifers with a smaller cohort of deciduous and evergreen broadleaf plants. Within five years after harvest, plant cover exceeded pre-harvest values, but was dominated by herbs and shrubs, and shrubs dominated by twelve years after harvest. By twenty-three years after harvest, the vegetation was dominated by evergreen shrubs and conifers on hillslopes, and red alder in riparian zones. Summer streamflows recovered to pre-harvest levels within five years, apparently in response to high water use by herbs and shrubs. Ten to fifteen years after harvest, streamflows were lower than before forest canopy removal, apparently because of water use by the shrub, conifer, and alder vegetation. Current research is quantifying water use by red alder, young Douglas-fir, and old-growth Douglas-fir and western hemlock (in Watersheds 1 and 2).

Stream ecosystem processes

Riparian vegetation, alternative stream flow pathways, the presence of primary producers and functional groups of aquatic insects, and the presence of wood affect nutrient dynamics in streams. By experimentally adding nitrogen and phosphorous to streams and measuring the uptake length or "spiraling", researchers are effectively taking the "pulse" of the stream, using ecosystem function as a measure of watershed health. Whole stream metabolism is an ecosystem process that can be measured by looking at dissolved oxygen levels over a 24-hour period, providing information about primary production and respiration within the stream. These studies are part of a collaboration between several Long Term Ecological Research (LTER) sites across the U.S. to evaluate measures of stream health that could be applied to a variety of biomes.

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